

Human-Centered Intelligent Systems for Mission Operations

Jane T. Malin
and team

**Intelligent Systems/Human Centered Systems
Project Review 10/24/02**

Team Members

- Analysis and design methods
 - Carroll Thronesbery, Kathy Johnson, David Overland
- System management agents and simulation
 - Debra Schreckenghost, Land Fleming and Lou Flores
- Information assistant agents and team tools
 - Arthur Molin, Grace Lei, Dan Smith, Patrick Oliver, David Overland
- Team tools and mission spin-offs
 - David Overland, Gene Peter and Kevin Taylor (DV) and Kathy Johnson (SD – SMART project for SURGEON/BME)

Project Objectives

- Cooperating intelligent agents for future heterogeneous distributed multi-tasking teams
 - Intelligent Systems Management Agents (ISMAs) designed for multi-agent teamwork
- New human-centered methods for prototyping intelligent agents and their operations infrastructure

FY01 Findings

- Need additional type of agent to support operations teams
 - Information management agents: Intelligent Briefing and Response Assistants (IBRAs)
 - Customizable, simpler, using same tools as operations team
- Importance of infrastructure and work integration
 - Need suite of information handling tools for agents and operations teams,
 - Support incremental agent development

FY01 Operations Concept: Space and Ground Periodic Cognizance/orienting with Support for Team Response

Vehicle/crew

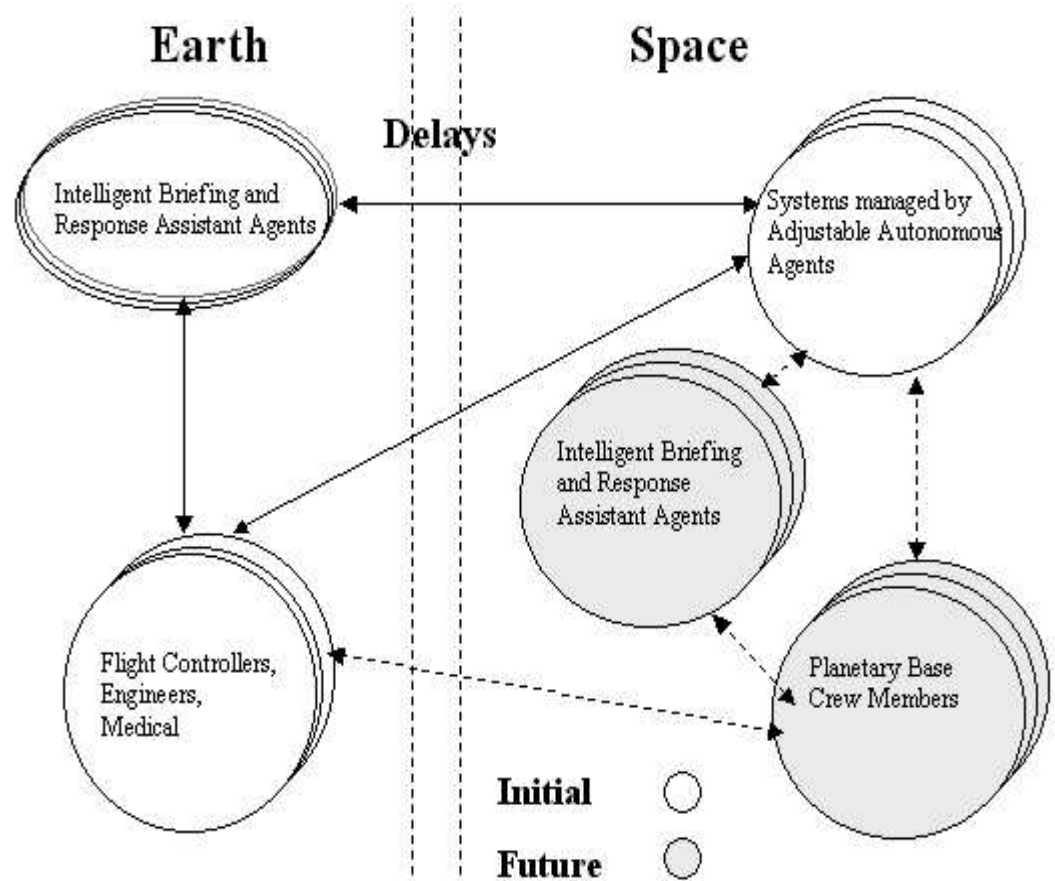
- Increased level of crew/vehicle autonomy
- Includes both crew and ISMA software
- Software does the vigilant monitoring
- Crew manages by exception

Multi-discipline officers

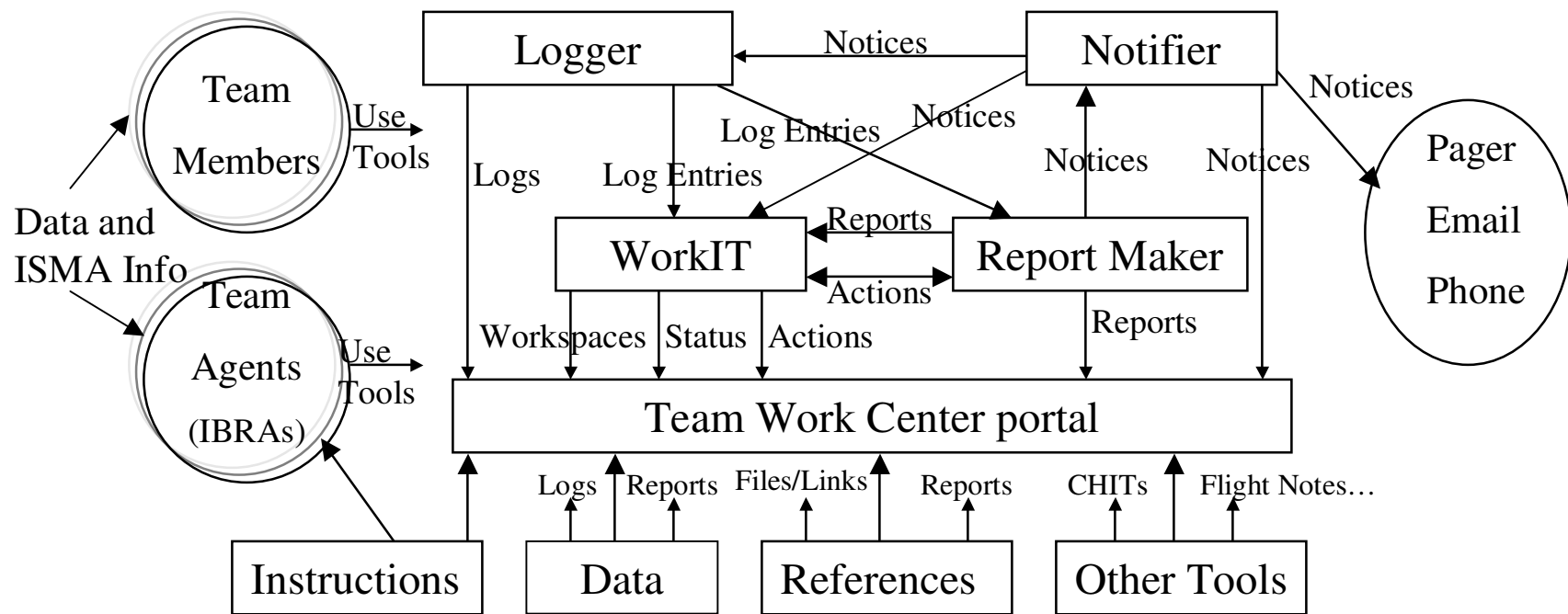
- Includes both person and IBRA software
- Vigilant monitoring, notify specialists of problems
- Works shifts in mission control center (MCC) only

Discipline specialists

- Flight controller functions
- Intermittent monitoring
- Works in MCC and office
- Includes both person and IBRA software
- Responsibilities beyond current mission



FY01 Linked Tools Concept: Used by Agents and Team Members

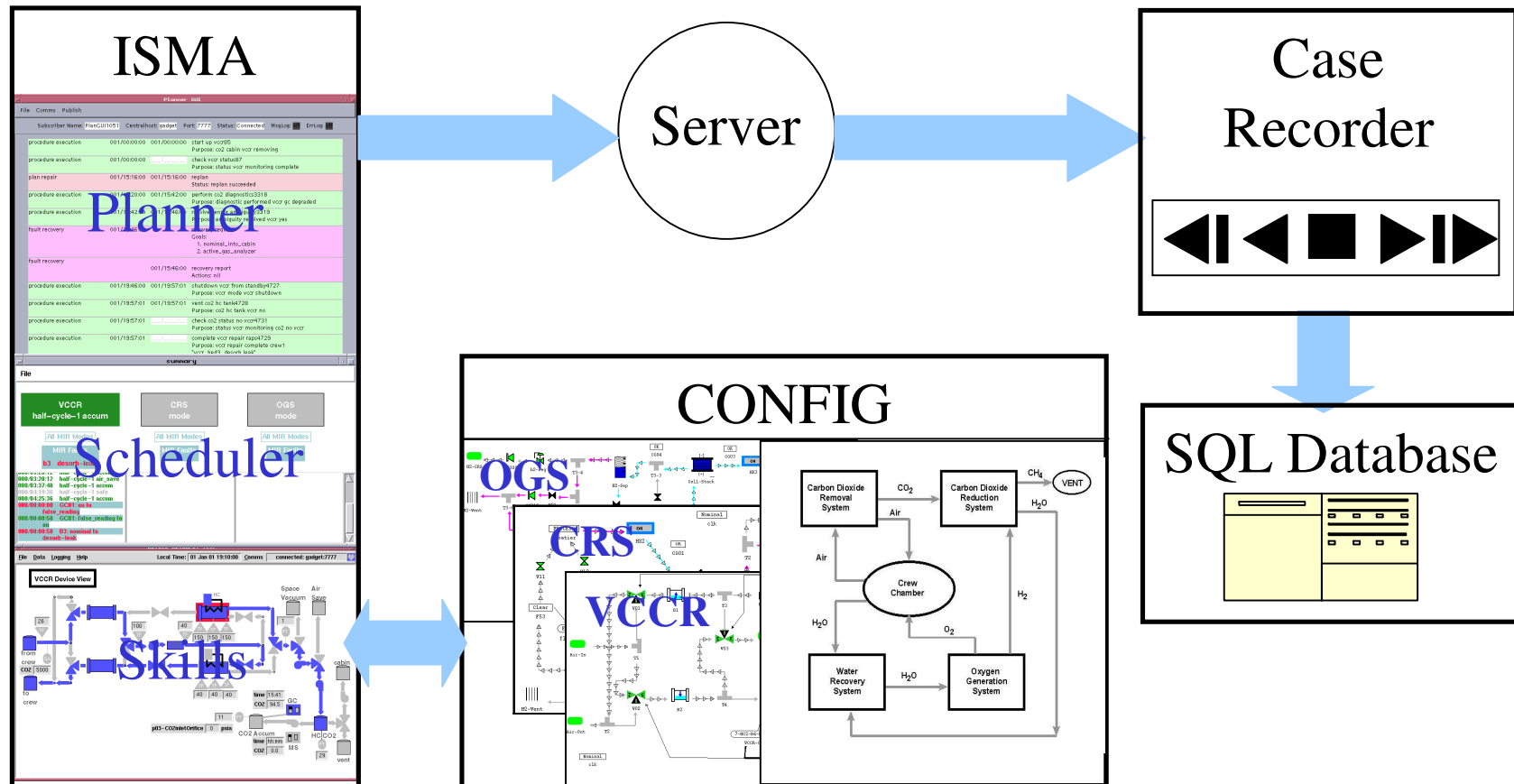


A team member enters content once, for use in multiple places

FY02 Task Areas

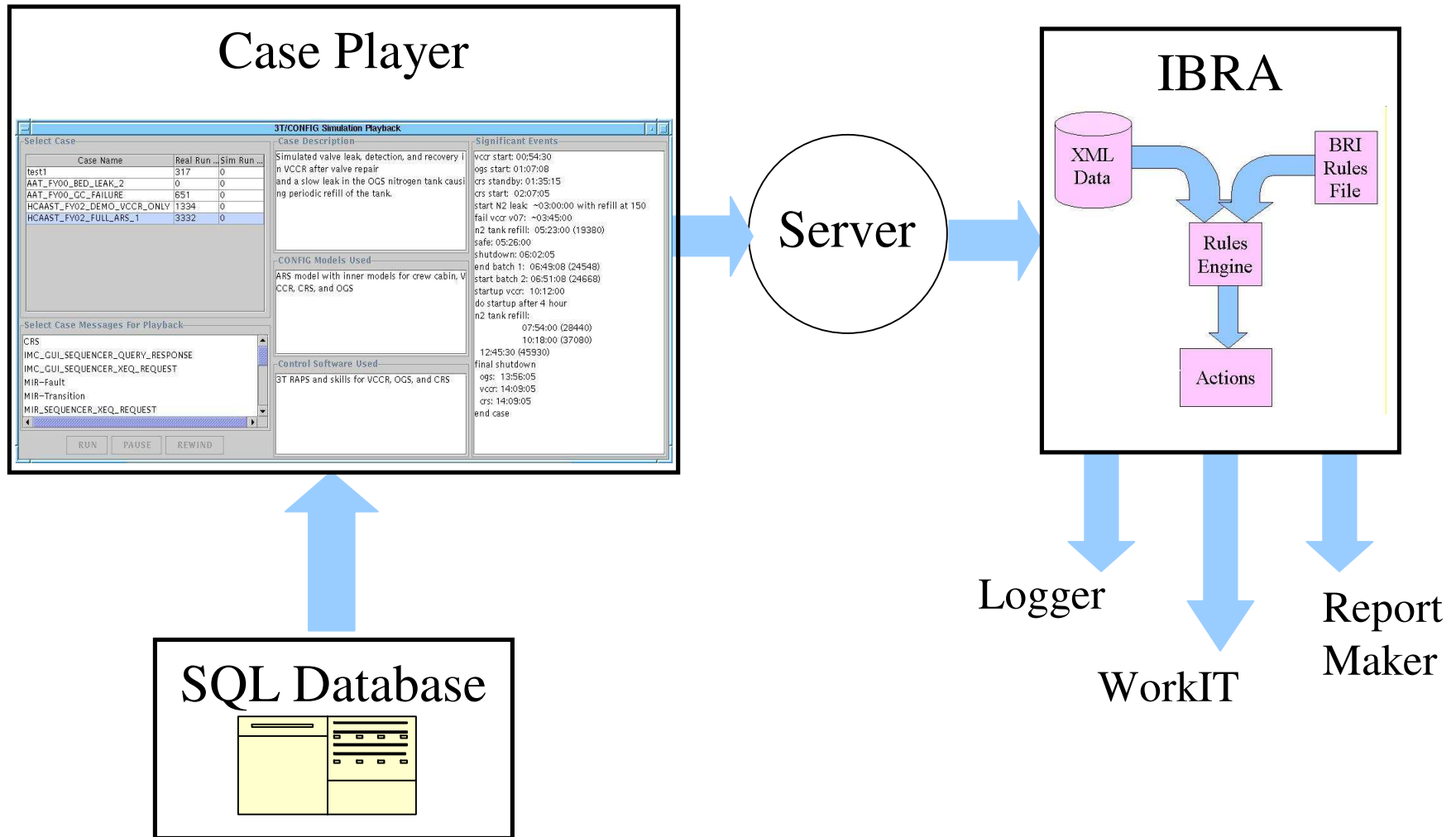
- Testbed for autonomous control agent
- Agent information and control
- Information handling tools and infrastructure for agent communication and control
- Human-centered methods for designer-developer teams

Testbed Architecture: ISMA, Simulation, Case Server Recording a Case for Playback



Testbed Architecture: Life Support Control Scenarios

Playing Back a Case



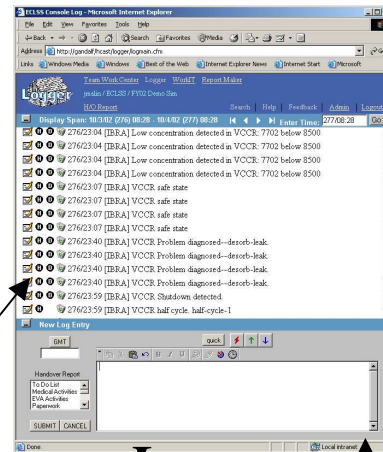
Web-based Information Handling Tools



API
(http)

API
(http)

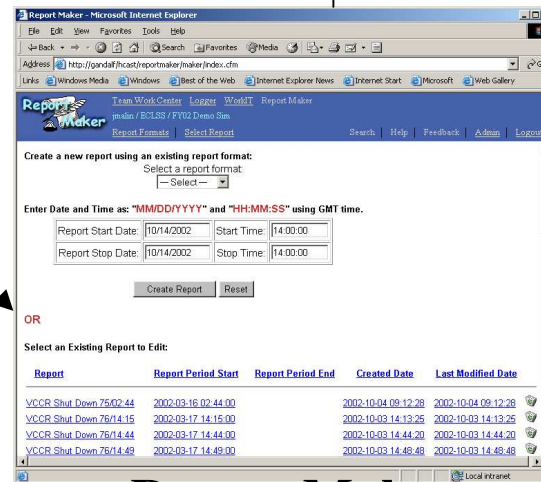
API
(http)



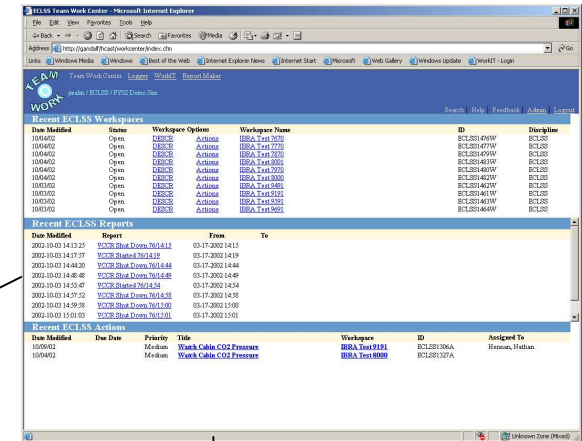
Logger

SQL

API
(http)

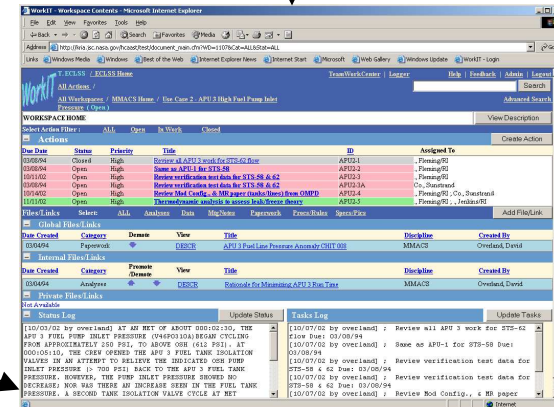


Report Maker



Team Work Center

API
(http)



WorkIT

Instructions for Intelligent Briefing and Response Assistants

- Inspired by mission operations Anomaly Response Instructions (ARIs)
 - For Station Duty Officers (SDOs) before the Space Station was manned
 - Filter, organize and distribute information on system status and anomaly response

ECLSS01 - NODE 1 RAPID DEPRESS

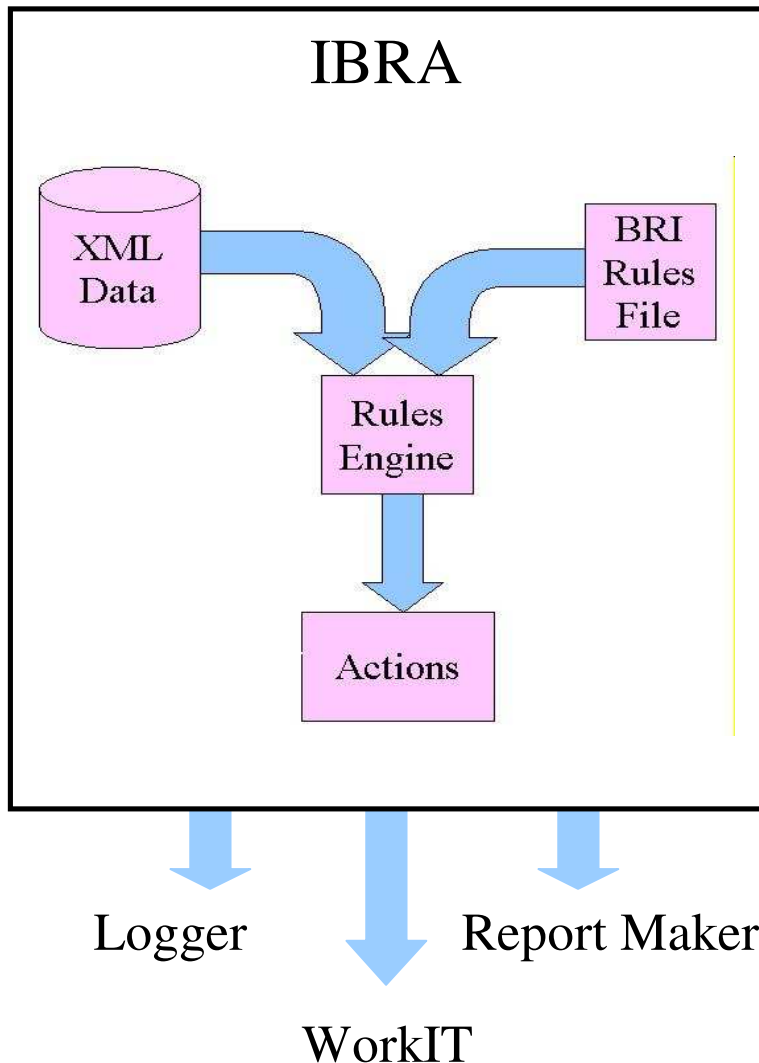
PURPOSE: To provide the SDO required actions upon receiving the ECLSS01 - Node 1 Rapid Depress ELOG Message

BACKGROUND: There is no onboard calculation of Node 1 rapid depressurization. A ground comp is used to calculate the Node pressure decay rate. The comp is susceptible to giving false readings if there are data interruptions or if there is a cabin pressure sensor bias or failure.

PROCEDURE

1. From the SDO display, record Node 1 cabin pressure.
2. From the SDO display, record Node 1 dPdt.
3. From the ECLSS SDO RTPLOT, check Node 1 pressure decreasing. Record slope, then multiply by 60 to get mm/hr.
4. If, after 30 minutes, there is a decrease in Node 1 Cabin pressure, call ECLSS, HSG, CATO, and Flight.

Briefing and Response Instructions



- Recognize complex patterns in input data
 - Use XML as the common data format
- Trigger actions in response to those patterns
 - Uses existing rule-based engine
 - Invoke user's tools
- BRI rules
 - Easily generated and modified
 - Flexible and powerful

Example Briefing and Response Instruction Code

```
<lml:rule name="co2_conc_accum_low">
  <lml:lhs>
    <Activity>?a</Activity>
    <new-value>
      <time> ?t&(?t>1) </time>
      <variable>'co2-concentration_hc_tank'</variable>
      <value> ?v&(?v<8500)</value>
    </new-value>
  </lml:lhs>
  <lml:actions>
    <elogger>
      <attr name="loggerURLString"
        value="http://gandalf/hcast/logger/insert_into_log.cfm" />
      <attr name="loggeragent" value="IBRA" />
      <attr name="loggertimestamp" value="?t" />
      <attr name="loggerlog_text"
        value="[IBRA] Low concentration detected in VCCR: ?v below 8500" />
    </elogger>
  </lml:actions>
</lml:rule>
```

**If CO₂ concentration
< 8500**

Make log entry

Logger: Log entries with metadata

The screenshot displays the 'Logger' application window. The title bar includes links for 'Team Work Center', 'Logger', 'WorldT', and 'Report Maker'. The user is logged in as 'jmalin / ECLSS / FY02 Demo Sim'. The interface features a navigation bar with 'H/O Report', 'Search', 'Help', 'Feedback', 'Admin', and 'Logout'. A status bar at the top indicates the 'Display Span: 10/20/02 (293) 18:27 - 10/21/02 (294) 18:27' and includes a 'Go' button next to the 'Enter Time: 294/18:27' input field.

The main log area contains several entries, each with a timestamp, a status icon, and a description:

- 294/07:40 Reviewed Flight note OPFN518 with all the procedures that the crew wants to delete on the MPV- there is nothing in there that we need to keep.
- 294/07:41 Marshall called and asked if we could inhibit the LAB1S2 SD because of bringing down the HRF rack. Completed the inhibit for the SD.
- 294/07:42 SKV 1 is deactivated as per the plan.
- 294/07:50 Reviewed an e-mail (internal note was not coming through) for the changes to the emergency procedures because of a page numbering issue. This is now a flight note.
- 294/07:54 [IBRA] VCCR half cycle. half-cycle-1
- 294/09:09 [IBRA] VCCR half cycle. half-cycle-2
- 294/09:53 [IBRA] Low concentration detected in VCCR: 7603 below 8500
- 294/09:53 [IBRA] N2 Tank Refill.
- 294/09:56 [IBRA] VCCR safe state

At the bottom, there is a 'Handover Report' section with a 'To Do List' and a 'SUBMIT' button. A 'quick' button and a 'GMT' button are also visible. The status bar at the very bottom shows 'Applet started' and 'Local intranet'.

Taking Advantage of ISMA High Level Information

- Intelligent System Management Agents support routine system management, assessment and safing
 - Not only monitor, detect and respond (e.g., safe the system), but also assess and plan
 - Use high level assessment, planning and procedure information to support supervision and anomaly response
 - New levels of intervention in procedures or plans?
 - New types of information about systems and ISMAs
 - Conveyed to team members by IBRAs using tools

IBRA-Generated Event Report with ISMA Information (Print Version)

VCCR Shut Down

Report generated 295/15:09

Author

IBRA Instruction VCCR_Shutdown

Trigger Value

VCCR Shutdown

Cause of Shutdown

Bed 3 leak

Time of shutdown

295/07:18

Procedure

PERFORM-CO2-DIAGNOSTICS

FIX-VCCR-PROBLEM-AMBIGUOUS-STATE

MONITOR-ARS

Result

DIAGNOSTIC-PERFORMED GC-DEGRADED

Evidence of problem [plot]

Action taken


Maintenance entered in crew schedule

Caution

Watch cabin CO2 concentration for health risk to crew [Text added by ECLSS in IBRA instruction]

Comments

Report Maker: Create and Use Editable Report Formats

[Team Work Center](#) [Logger](#) [WorldIT](#) [Report Maker](#)
jmalin / ECLSS / FY02 Demo Sim
[Report Formats](#) | [Select Report](#)[Search](#) | [Help](#) | [Feedback](#) | [Admin](#) | [Logout](#)

Create a new report using an existing report format:

Select a report format:





Report Name:

Enter Date and Time as: "**MM/DD/YYYY**" and "**HH:MM:SS**" using GMT time.

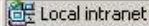

| | | | |
|--------------------|---|-------------|---------------------------------------|
| Report Start Date: | <input type="text" value="10/21/2002"/> | Start Time: | <input type="text" value="20:00:00"/> |
| Report Stop Date: | <input type="text" value="10/21/2002"/> | Stop Time: | <input type="text" value="20:00:00"/> |

OR


Select an Existing Report to Edit:

| <u>Report</u> | <u>Report Period Start</u> | <u>Report Period End</u> | <u>Created Date</u> | <u>Last Modified Date</u> | |
|--|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|---|
| Daily | 2002-10-20 19:00:00 | 2002-10-21 19:00:00 | 2002-10-21 19:07:57 | 2002-10-21 19:07:57 |  |
| Handover | 2002-10-21 02:40:00 | 2002-10-21 10:40:00 | 2002-10-21 19:07:16 | 2002-10-21 19:07:16 |  |
| VCCR Shut Down 294/18:22 | 2002-10-21 18:22:00 | | 2002-10-21 19:04:46 | 2002-10-21 19:04:46 |  |
| VCCR Started 294/18:23 | 2002-10-21 18:23:00 | | 2002-10-21 19:05:35 | 2002-10-21 19:05:35 |  |

Page generated on October 21, 2002
Template last modified on October 21, 2002
Web Curator: [Patrick Oliver](#)



Example Handover Report (Editable Format)



[Team Work Center](#) [Logger](#) [WorkIT](#) [Report Maker](#)
[jmalin / ECLSS / FY02 Demo Sim](#)
[Report Formats](#) | [Select Report](#)

[Search](#) | [Help](#) | [Feedback](#) | [Admin](#) | [Logout](#)

Report: Handover From: 10/21/02 02:40:00 To: 10/21/02 10:40:00 [New Handover Report](#) [Preview](#) [Print Version](#) [Change Period](#)

ECLSS Handover Report

Monday October 21, 2002 (294)

Big Picture

Edit

Accomplishments This Shift

Edit

Anomalies

| | |
|-----------|--|
| 294/09:53 | [IBRA] Low concentration detected in VCCR: 7603 below 8500 |
| 294/09:56 | [IBRA] VCCR safe state |
| 294/10:32 | [IBRA] VCCR Shutdown detected. |

| Recent Anomalies | GMT | IFI(FIW) | Add Row to Bottom |
|------------------|-----|----------|-------------------|
| | | | |

Edit the Paragraph Text:

This is the big picture for ECLSS....

Save Changes

Reset

Cancel

Done

Local intranet

WorkIT: Organized and searchable Issue Workspaces with Actions, Reference materials, Status of tasks and issues

The screenshot displays the WorkIT web application interface. At the top, there is a navigation bar with links for 'T.ECLSS / ECLSS Home', 'TeamWorkCenter | Logger', 'Help | Feedback | Admin | Logout', and a search bar. Below this, there are links for 'All Actions /' and 'All Workspaces / SURGEON Home / TEPC download (Open)'. The main content area is divided into several sections:


- WORKSPACE HOME**: Includes a 'View Description' button.
- Select Action Filter**: Options for 'ALL', 'Open', 'In Work', and 'Closed'.
- Actions**: A table listing actions with columns for Due Date, Status, Priority, Title, ID, and Assigned To.
- Files/Links**: A section with a 'Select' dropdown and buttons for 'Add File/Link'.
- Global Files/Links**: A section with a 'None' status.
- Internal Files/Links**: A table listing files with columns for Date Created, Category, Promote/Demote, View, Title, Discipline, and Created By.
- Private Files/Links**: A section with a 'Not Available' status.
- Status Log**: A section with an 'Update Status' button and a text area for logging status changes.
- Tasks Log**: A section with an 'Update Tasks' button and a text area for logging tasks.

The interface is designed for managing tasks and issues, providing a structured way to track progress and communicate about specific problems.

| Due Date | Status | Priority | Title | ID | Assigned To |
|----------|--------|----------|--|--------------|---------------------------|
| 10/25/01 | Closed | Medium | BME download files from MEC | SURGEON1138A | *A, BME |
| 01/02/02 | Open | Medium | Engineering assess downlinked file | SURGEON1139A | |
| 10/11/02 | Open | Medium | test this | SURGEON1146A | , SPAN ; Dershowitz, Adam |

| Date Created | Category | Promote /Demote | View | Title | Discipline | Created By |
|--------------|----------|--|-----------------------|---------------------|------------|----------------|
| 05/03/02 | | Promote Demote | DESCR | IFI | SURGEON | Johnson, Kathy |

Team Work Center: Portal into Tools and Recent Work of Flight Discipline



[Team Work Center](#)
[Logger](#)
[WorkIT](#)
[Report Maker](#)

jmalin / ECLSS / FY02 Demo Sim

[Search](#)
[Help](#)
[Feedback](#)
[Admin](#)
[Logout](#)

Recent ECLSS Workspaces

| Date Modified | Status | Workspace Options | Workspace Name | ID | Discipline |
|---------------|--------|---|--|------------|------------|
| 10/21/02 | Open | DESCR Actions | Anomalous VCCR Shutdown 293/18:21 | ECLSS1157W | ECLSS |
| 08/02/02 | Open | DESCR Actions | Elektron Unexpected Shutdown | MER-0316 | ECLSS |
| 06/10/02 | Open | DESCR Actions | VRS leak rate higher than expected | MER-0348 | ECLSS |
| 01/17/02 | Open | DESCR Actions | SM BB2PO Fan Failure | MER-0328 | ECLSS |
| 10/28/01 | Open | DESCR Actions | VCCR shutdown | ECLSS1151W | ECLSS |
| 06/13/01 | Closed | DESCR Actions | FSS Contaminated with Water | MER-0397 | ECLSS |
| 05/30/01 | Closed | DESCR Actions | MCA N2 Electrometer Saturation | MER-0390 | ECLSS |
| 04/17/01 | Closed | DESCR Actions | High Cadmium Levels in Water | ECLSS1122W | ECLSS |

Recent ECLSS Reports

| Date Modified | Report | From | To |
|-------------------|--|------------------|-------------|
| 10/21/02 19:07:57 | Daily | 10-20-2002 19:00 | 10-21 19:00 |
| 10/21/02 19:07:16 | Handover | 10-21-2002 02:40 | 10-21 10:40 |
| 10/21/02 19:05:35 | VCCR Started 294/18:23 | 10-21-2002 18:23 | |
| 10/21/02 19:04:46 | VCCR Shut Down 294/18:22 | 10-21-2002 18:22 | |

Recent ECLSS Actions

| Date Modified | Due Date | Priority | Title | Workspace | ID | Assigned To |
|---------------|----------|----------|------------------------------------|---|------------|-------------|
| 10/21/02 | | Medium | Predict CO2 Levels | Anomalous VCCR Shutdown 293/18:21 | ECLSS1301A | |

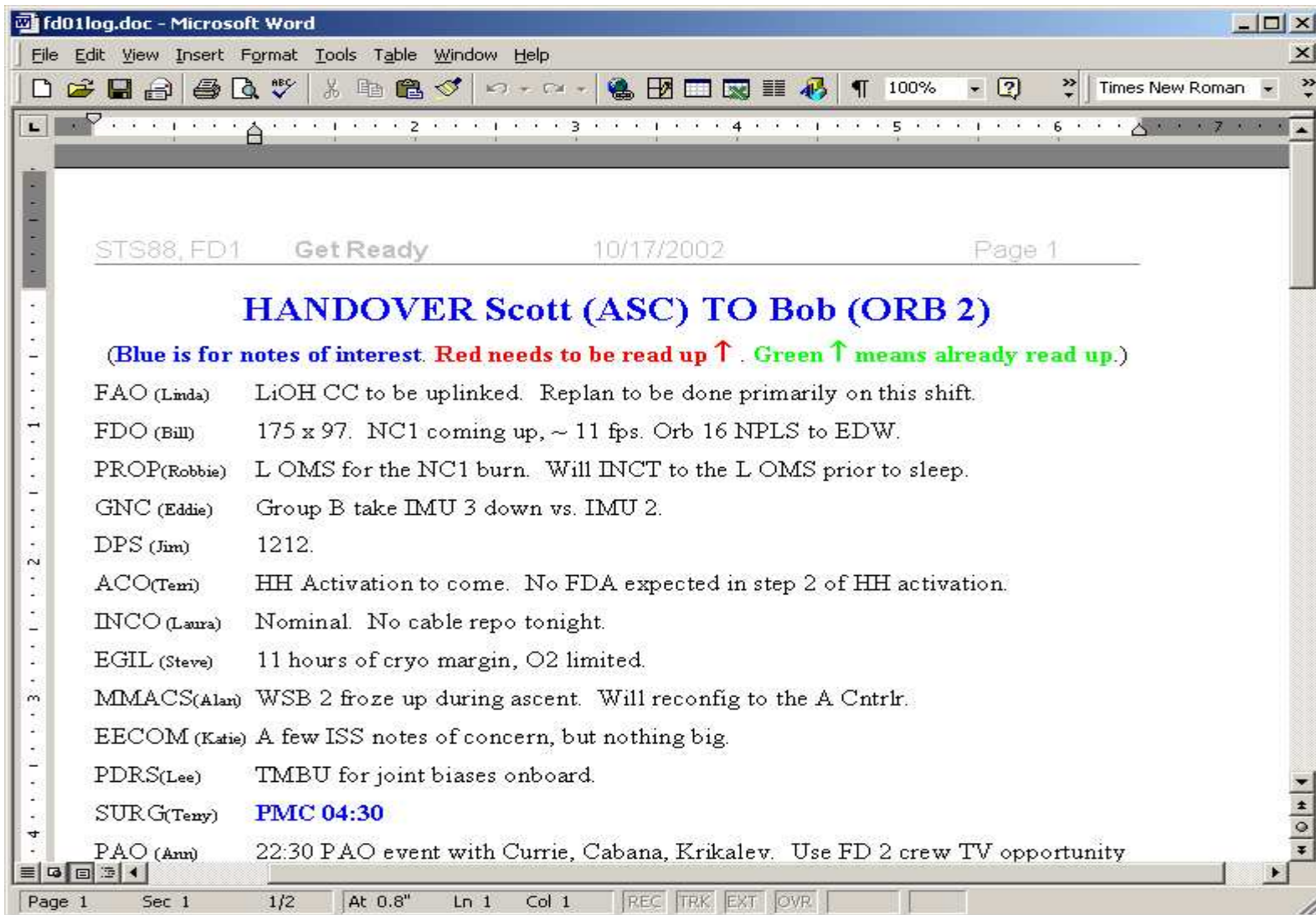
Human-Centered Methods for Development Teams

- Process and products for rapid prototyping teams
 - Designers, developers, users
 - Boundary objects for human-centered teams
 - Shared objects to talk about, think with, coordinate perspectives of constituencies (G. Fischer)
- Two different types of designer-developer teams
 - Electronic Console Logger and Report Maker
 - Tight team integration, one of developers is past user
 - WorkIT Evaluation and Enhancement
 - Loose team integration (separate organization), developer is not past user

HCS Evaluation Products

- Formative evaluation of prototype
 - Not just “How well did we do?”
 - What improvements and new capabilities are needed?
- Throughout Phases
 - Phase 1: Analysis Phase
 - Phase 2: Development Phase
 - Phase 3: Assessment and Refinement Phase
- Using Boundary Objects: Artifacts, use cases, annotated screen shots, annotated sketches

CAPCOM Log Artifact



Analysis Phase

- Goal: Gain enough understanding of the user task to design the first approximation to supporting it
- Initial interview(s) with the user to obtain
 - Use Case Scenarios
 - Artifacts – what is used and produced to meet task demands now?
 - Characteristics of team tasks and communication
 - Review of possible support strategies (partial designs)

BME Log Artifact

BME%20log%2010-26.doc - Microsoft Word

File Edit View Insert Format Tools Table Window Help

86% Arial

ISS Log Notes

Date: Friday, October 26, 2001 (299)

Week 10

Console Support

| FS / BME | GMT |
|----------------|-----------------------|
| Waks/AM Brooks | 295/04:00 – 295/13:00 |
| Avery | 295/12:00 – 295/21:00 |
| Cornelius | 295/20:00 – 296/05:00 |

AFD (Orbit 2)

| OPS PLAN | |
|----------|--|
| ECLSS | |
| SURGEON | Today's activities include Exercise File d/l, FFQ and MEC data d/l. MO6 was cancelled due to the move of the EVA. |

AFD (gaining)

| | |
|----------|--|
| OPS PLAN | 300-304 Due to Ammonia Loop issue with THOR, the LSOS may be deferred |
| THOR | There was a BIT flip in the EETCS Loop B. PVCU declared an ORU failure. This suspends all calculations but the pumps continue to run. |
| SURGEON | Exercise file download and MEC data download have been completed and we will be asking OCA to bring those files down. We have VOA powerdown procedure in SGFN855 approved for uplink Water activities have been moved from Monday's timeline to Wednesday per crew request |
| GC | LSOS on hold. Working with BME on 2 RSA PFCs on Saturday |

AFD (Orbit 1)

| | |
|----------|--|
| OPS PLAN | LSOS cancelled. O-300-304. Look at day 304 timeline. OP seems to think that there are 2 PFCs tomorrow for the Soyuz crew via US S-band Assets. BME is unaware of this. FD would like BME to double check this. |
|----------|--|

Page 1 Sec 1 1/9 At 1" Ln 1 Col 1 REC TRK EXT OVR

Prototype Development Phase

- Steer the implementation to support design intention
 - Spiral development
 - Reevaluation and planning as each core function is developed
 - Controlled requirements creep (no loss of focus)
 - Continual feedback between designers and developers
 - Analyze design decisions that make implementation difficult
 - Find efficient design alternatives that fit design intentions
 - Communication formats
 - Design support: Boundary objects (artifacts, annotated sketches and snapshots, partial prototypes)
 - Management support: WorkIT actions to track development tasks

Developers Links to Artifacts

Artifacts - HCAAST - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: <http://smaug.jsc.nasa.gov/hcast/hcc/ibra/artifacts.html> What's Related

[\[products\]](#) [\[readings\]](#) [\[description\]](#) [\[glossary\]](#) [\[top\]](#) [\[mailto:c.thronesbery@jsc.nasa.gov\]](mailto:c.thronesbery@jsc.nasa.gov)

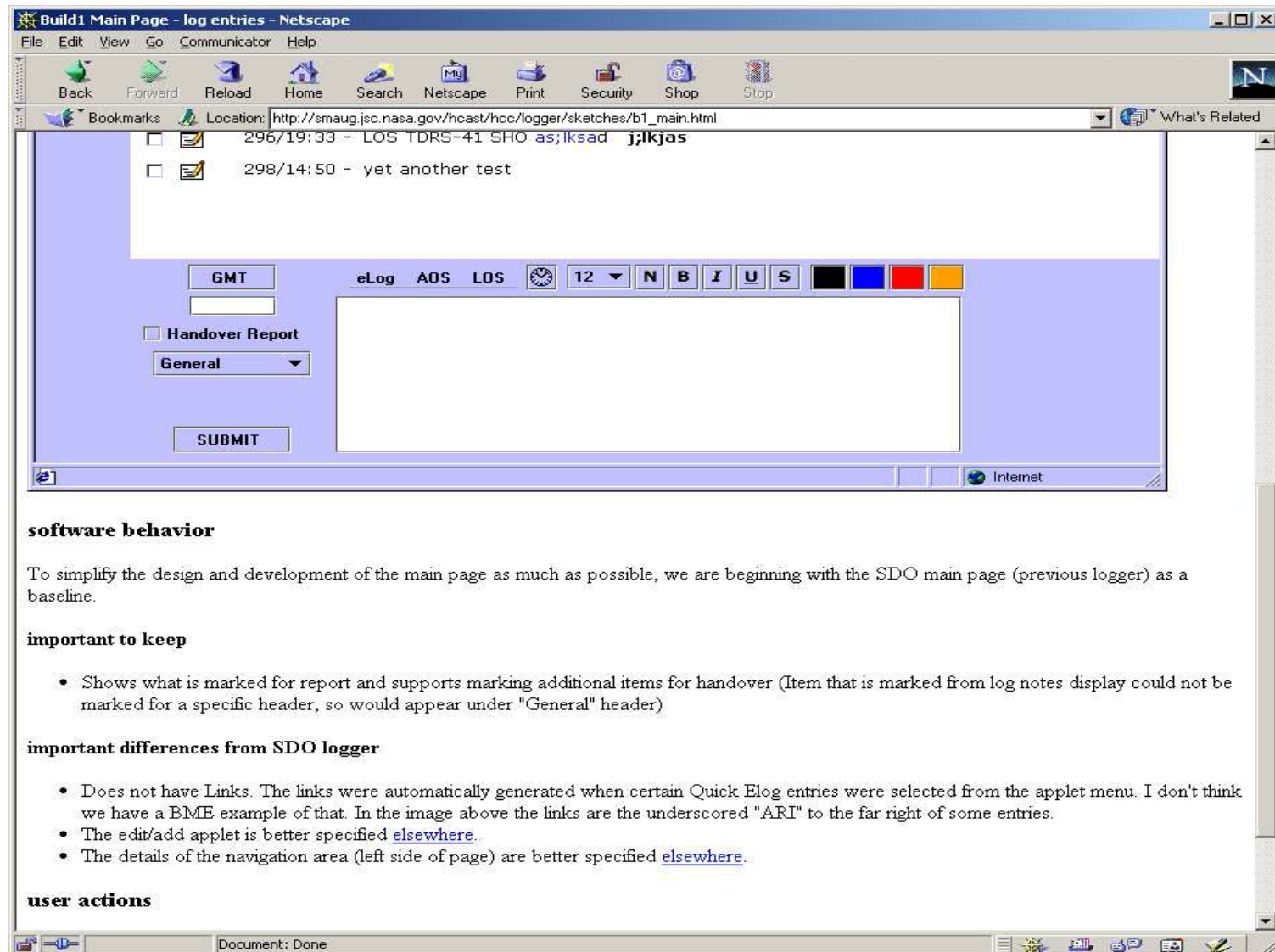
05 Apr 2002

Artifacts HCAAST

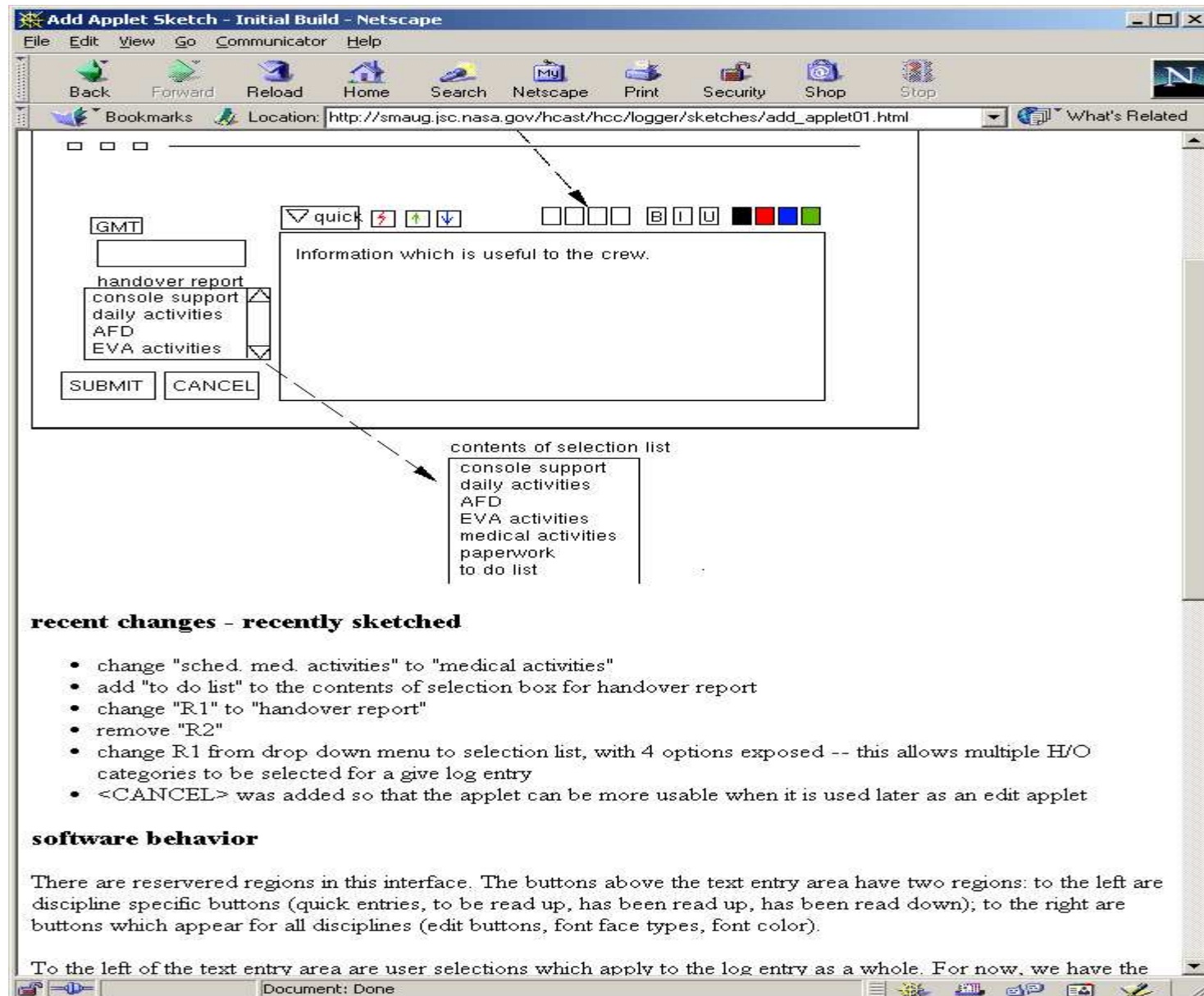
| artifact | project | original tasks | significance to original task | HCAAST tasks | significance to HCAAST task |
|--|--|---|--|---|---|
| ISS ECLSS Documentation <ul style="list-style-type: none"> 4.1. CDRA Hardware and Function Description (doc) 7.2. Waste Water Vent Hardware and Function Description (doc) Training Manual (pdf) ECLSS System Overview (gif) | ISS ECLSS Flight Controllers | monitoring CDRA (Carbon Dioxide Removal Assembly, very similar to VCCR) and waste water vent hardware | These documents can provide some familiarity with the ISS ECLSS flight controllers tasks to improve the quality of information we are able to obtain from them related to IBRA review of anomaly situations. | <ul style="list-style-type: none"> reviewing anomalies right after they have occurred consulting related documentation coordinating with others to respond to anomaly | Can help guide data collection from ISS ECLSS flight controllers which is relevant to IBRA situation review. Can help to provide context for interpreting this information once it has been gathered. |
| ISS ECLSS Shift H/O notes and Console Log notes <ul style="list-style-type: none"> not yet available digitally notes about artifacts 2 log examples, one joint Shuttle/Station, the other Station only 2 shift h/o examples, related to the joint ops logs | Console Logger ISS ECLSS Flight Controllers | monitoring ECLSS systems for Space Station and Shuttle (2001) | These documents can provide some familiarity with the ISS ECLSS flight controllers tasks to improve the quality of information we are able to obtain from them related to IBRA review of anomaly situations. They also provide specific examples of what is logged at the console and how shift handovers are constructed. | <ul style="list-style-type: none"> reviewing anomalies right after they have occurred consulting related documentation coordinating with others to respond to anomaly computing specific impacts of possible failures | Can provide specific examples of how ECLSS flight controller might use the console logger. |

Document: Done

Annotated Screen Snapshot



Annotated Sketch



WorkIT Actions: Track Problems

WorkIT - Workspace Contents - Netscape

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: ov/hcaast/test/document_main.cfm?WD=1090&Cat=ALL&Stat=Open&Nav=Dmain What's Related

C. Thronesbery / TESTGRP Home TeamWorkCenter | Help | Feedback | Admin | Logout
Logger

WorkIT All Actions / Search

All Workspaces / TESTGRP Home / Advanced Search

logger development (Open)

WORKSPACE HOME View Description

Select Action Filter : ALL Open In Work Closed

Actions Create Action

| Due Date | Status | Priority | Title | ID | Assigned To |
|----------|--------|----------|--|--------------|---|
| | Open | Medium | Submit failure with cryptic error message | TESTGRP1263A | Jenks, Kenneth ; Oliver, Pat |
| 10/22/02 | Open | Medium | Anchor button in applet does not function properly | TESTGRP1257A | Jenks, Kenneth ; Oliver, Pat |
| 10/15/02 | Open | Medium | Need focus in the applet after using buttons | TESTGRP1255A | Jenks, Kenneth |
| 10/08/02 | Open | Medium | Mysteriously disabled buttons | TESTGRP1240A | Jenks, Kenneth |
| | Open | Medium | Build view-log-entry-in-context | TESTGRP1177A | Oliver, Patrick |
| | Open | Medium | Formally evaluate | TESTGRP1171A | Thronesbery, Carroll |
| | Open | Medium | informally evaluate | TESTGRP1168A | Thronesbery, Carroll |
| | Open | Low | Implement general search page | TESTGRP1186A | Acucsi, Tony ; Smith, Dan ; Thronesbery, Carroll |

Files/Links Select: ALL Analyses Data MtgNotes PaperworkProcs/RulesSpecs/Pics Add

Global Files/Links

| Date Created | Category | Demote | View | Title | Discipline | Created By |
|--------------|----------|--------|-------|---------------------------|------------|----------------------|
| 08/06/02 | | ↓ | DESCR | Logger | TESTGRP | Thronesbery, Carroll |
| 08/06/02 | | ↓ | DESCR | header sketch | TESTGRP | Thronesbery, Carroll |
| 05/16/02 | | ↓ | DESCR | logger development tasks | TESTGRP | Thronesbery, Carroll |
| 05/16/02 | | ↓ | DESCR | Build 1 coordination site | TESTGRP | Thronesbery, Carroll |
| 05/16/02 | | ↓ | DESCR | console logger sketches | TESTGRP | Thronesbery, Carroll |

Document: Done

Assessment and Refinement Phase

- Use case test by designers
 - Can designers perform user tasks as expected?
 - Reproducing artifacts keeps evaluation focused on user tasks
- Initial evaluation – user performs basic tasks
 - Address 3 Us (understanding, usefulness, usability)
 - Use case scenarios keep evaluation focused on the tasks
- Take home and use – expose deeper level issues
 - Identify hidden tasks and persistent difficulties
- Interviews and focus groups after take-home use
 - Explore specific evaluation objectives and issues
 - Review designs for next prototype iteration, with boundary objects

Important Human-Centered Practices

- Focus on designer \leftrightarrow developer interactions
 - Support prototyping without firm requirements
 - Support redesign and detailed design that balances design intentions and implementation concerns
- Useful boundary objects “common language”
 - Used by multiple groups in multiple development phases
 - Each group can interpret object’s implications for their interests
 - Representing general cases with implications for design
 - With annotations, objects can represent task characteristics, design intent, design implications
 - Concrete – for specific communication
 - Each group can point at the object for common reference

FY02 Demonstration

- ISMA manages air processing systems as specified
 - Reports status and operations of simulated system
 - Makes anticipated response to handle system problem (leak)
- IBRA manages information from ISMA according to team instructions
 - When triggered, makes log entries, constructs event reports, and uses a workspace
- Flight Controllers periodically review information and handle system problems
 - Supported by tools containing ISMA-IBRA information and information from the ECLSS team

Mission Spin-offs

- SMART project: Issue Tracking support for Space Station BME/Surgeon discipline
 - WorkIT prototype evaluated, enhanced, ready for conversion to BME use in missions, for further evaluation and enhancement.
 - User organization will provide funds
 - Prototype will be enhanced for use by other disciplines, starting with ECLSS
- Logger, Report Maker and Team Work Center prototypes are ready for BME evaluation

Benefits of Cooperating Intelligent Agents

- Freedom from some system management tasks
 - ISMA autonomous system control
- Flexibility in directing and changing agent services
 - ISMA adjustable agent with replanning
 - IBRA instructions from users
- Improved understanding and information handling while busy with other tasks
 - ISMA high level event information
 - IBRA log entries, situation reports and analyses
 - Team Work Center tools for information organization and asynchronous communication
 - Addresses today's problems: too many interruptions, hard to find pertinent information from earlier episodes, hard to reuse information

FY03 Plans

- Develop tool for specifying IBRA instructions
- Develop concepts for team-to-agent coordination and communication during anomalies
 - Identify needed agent enhancements
- Advance tools and agent-tools architecture
- Advance and refine human-centered methods
 - Investigate incremental requirements development during rapid prototyping, using boundary objects